ATTACHMENT 9

Accelerated Corrosion/Durability Test Procedure

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(PROVIDED FOR INFORMATIONAL PURPOSES ONLY)

Accelerated Corrosion/Durability Test Procedure

Background

This document describes the accelerated corrosion/durability test procedure (ACT) developed specifically to gather baseline data on the corrosion performance of the Family of Medium Tactical Vehicles (FMTV) design with corrosion upgrades. Because this test was designed specifically for the FMTV, it will be referred to herein as "FMTV ACT." The test plan is a living document to guide the development of the test procedures and facilities. The final document will serve as a record of the actual test procedures.

Corrosion testing is combined with durability testing to improve our ability to evaluate the interaction between corrosion and physical stresses that act upon a vehicle. The interaction of these stresses very often cause different service failures than might be revealed by either corrosion or durability testing alone. Due to the nature of military activities, the actual service environment of a specific vehicle can never be accurately forecasted. In times of crisis, vehicles can be called to any environment in the world for an extended period of time. Vehicles will need to effectively operate within all environments in order to ensure that no failures occur that can jeopardize soldiers' lives. In times of decreasing acquisition and maintenance budgets, it is important that weapon systems are acquired with an appreciation of the total life cycle cost of the system. Material systems with exceptional performance capabilities can be developed and acquired, but they may have an enormous acquisition cost. Other materials that have been historically used may require excessive maintenance when placed in some of the severe environments that military vehicles operate within. A compromise must be made between performance and maintenance requirements to obtain the best total life cycle cost benefit from selected material systems.

The FMTV ACT will generate the appropriate information to determine what corrosion performance and maintenance requirements may be expected for vehicles in the target environment. It will not likely be cost effective to design all vehicles for zero corrosion in the target environment. However, given an expectation of the vehicle performance requirements, we can use the FMTV ACT test results to identify areas that do not provide the desired level of material performance (i.e., experience unacceptable levels of corrosion).

Projected FMTV Fielding Profile

The present test was developed around a fielding profile that includes exposure in many different types of environments. The breakdown is as follows:

Environment	Percentage
US/Germany/Korea	54
Desert	25
Marine/Tropical	15
Far East	5
Arctic	1

The US/Germany/Korea vehicles represent many different marine, rural, and industrial areas of exposure. They represent locations within severe, mild, moderate, and negligible automotive corrosion environments.

A significant portion of the fielding profile includes marine or tropical environments. It is important to make sure that the test cycle properly incorporates corrosion that occurs from salt deposition present in the air that can deposit on the top and sides of vehicles. Additionally, many vehicles will be exposed in areas that employ road-deicing salts. It will be important to make sure that the test cycle properly incorporates corrosion that occurs from salt deposition from high concentration salt water on roadways during low and high speed driving. The roadway surfaces should include all possible roadway surfaces, including paved, gravel, and dirt/mud surfaces. Corrosive environmental constituents representative of materials found in marine, rural, and industrial environments will be incorporated in the test.

Severity of Exposure

The automotive industry has an extensive database on the corrosion requirements of its customers. As a result they can predict the material corrosion resistance required for vehicle performance. The army will derive its requirements from the commercial automotive industry's experience.

The Army's service environment is different than that of the commercial automotive customer. Driving will include more off-road applications and hauling of heavy loads. Vehicles may also undergo long periods of static exposure at training locations, or pre-position locations on the open sea. The maintenance level will be different. The impact of these variations is not known, but it is anticipated that the army service environment is as severe as the worst commercial environment, if not more severe. As a result, the present test protocol establishes target corrosion penetration levels based on the most severe penetration used by General Motors in their proving ground test. Table 1 provides the target corrosion penetration levels.

Table A 1. Test Year Cumulative Control Coupon Corrosion Penetration Targets

Test Year (Phase)	Cumulative Penetration (mm*)	Test Year (Phase)	Cumulative Penetration (mm*)
1	23±30%	12	390±10%
2	60±25%	14	450±10%
4	140±15%	16	510±10%
6	210±10%	18	570±10%
8	270±10%	20	630±10%
10	330±10%	22	690±10%

* Micrometers (μm) is calculated by knowing the coupon mass loss, geometry of the coupon and density of the coupon material (Appendix B contains further explanation of these values and lists the equation used to derive them). The penetration is an average of the attack on all surfaces of the coupon (i.e., assumes uniform attack over the entire surface of the coupon).

Corrosion Test Events

Many different environmental and physical stresses act upon a vehicle during its life. The stresses affect metals, plastics, coatings, greases, ceramics, etc. in different fashions. There are also numerous types of corrosion that act upon a vehicle in different circumstances and at different rates. The test procedure is set up according to commercial experience to best simulate corrosion phenomena that limit a vehicle's useful life. Specifically, this includes identifying the ability of the paint system to resist any types of defects, the identification of any crevice corrosion that may lead to rust bleed-out and rust staining, and identifying any corrosion that causes failure of any working components of the vehicle. Corrosion test events are designed to:

- Apply different corrosive contaminants that are likely to be present in different service environments;
- Work those contaminants onto/into all surfaces of the vehicle that may occur during the expected use of the vehicle; and
- Create an environment where the corrosion caused by these contaminants will occur at an accelerated rate.

Applying contaminants and working them onto/into all appropriate surfaces of the vehicle occurs simultaneously throughout the FMTV ACT test events. The corrosion mechanisms are accelerated through the use of an environmental chamber that will maintain a high temperature, high humidity environment. The amount of time spent within the chamber is used to control the severity of the corrosion on the test vehicles throughout the test.

Corrosion test events fall into four categories as follows:

- **Event** refers to the lowest level of vehicle driving activity. Each individual corrosion or durability input is considered to be an event.
- **Cycle** refers to the group of events that are completed in a working day. The sequence of events in Table 2 is considered to be a cycle.
- **Phase** refers to a test year. One phase is composed of 15 cycles.
- **PMCS** refers to Preventative Maintenance Checks and Services. These are performed after test cycles and phases according to the schedule at the end of this document. Note that PCMS schedule has been modified slightly to accommodate the accelerated nature of the test.

Projected FMTV Mission Profile

The current corrosion/durability test was designed for an expected mission profile that includes driving on four different surfaces shown below. This mission profile will be executed by two test vehicles, one tested as manufactured baseline and one tested following application of maintenance products for additional corrosion prevention.

Surface	Percentage of Travel
Primary Roads (HSTT)	20
Secondary Roads (Gravel Road)	50
Trails (Belgian Blocks)	15
Cross Country (Rolling Hills)	15

As a precursor to full-scale testing preliminary evaluations were performed. These evaluations were intended to characterize the operation of and exposure severity of test facilities available at Aberdeen Proving Ground. Appendix A contains the preliminary tests performed and an evaluation of each.

Driving Test Events

Several different test events are included in the Accelerated Corrosion Test. Each event is a corrosion and/or a durability input. The events are combined into a daily driving cycle as shown in Table 2. The driving cycle is executed each working day (i.e., excluding weekends and holidays). Fifteen (15) driving cycles, along with the humidity chamber phases necessary to achieve the target corrosion rates shown in Table 1, constitute one “test year.”

Table A 2. Daily Driving Test Cycle

Laps	Event	Miles
--	Grit Trough	--
3	Secondary Roads (Gravel Road)	6.3
--	Grit Trough	--
3	Secondary Roads (Gravel Road)	6.3
--	Grit Trough	--
5	Trails (Belgian Block) Secondary (Access to Trails)	3.5 2.0
--	Salt Splash/Mist	--
5	Primary Roads (High Speed Test Track)	5.0
--	Grit Trough	--
3	Cross Country (Rolling Hills) Secondary (Access to Cross Country)	2.4 1.7
--	Grit Trough	--
5	Trails (Belgian Block) Secondary (Access to Trails)	3.5 2.0
--	Grit Trough	--
4	Primary Roads (High Speed Test Track)	4.0
--	Salt Splash/Mist	--
7	Cross Country (Rolling Hills) Secondary (Access to Cross Country)	5.6 1.7
--	Grit Trough	--
3	Secondary Roads (Gravel Road)	6.3
--	Grit Trough	--
5	Trails (Belgian Block) Secondary (Access to Trails)	3.5 2.0
--	Grit Trough	--
3	Cross Country (Rolling Hills) Secondary (Access to Cross Country)	2.4 1.7
--	Grit Trough	--
4	Primary Roads (High Speed Test Track)	4.0

*Frame twister after 2nd and 22nd phases.

These test events are based on requirements established in the 1980's development of the FMTV ACT which have been recently modified to reflect the current state-of-the-art in vehicle corrosion durability testing. Changes allow for a more accurate and repeatable representation of vehicle corrosion requirements. Following are descriptions of each of the test event requirements. The descriptions are intended to describe the actual testing to be conducted, but are not necessarily a comprehensive test specification.

Grit Trough

Purpose. The purpose of the grit trough is to introduce small particles into various crevices and joints of the underside of the vehicle. Grit will accumulate in the crevices and on remote surfaces. The accumulated grit, or poultice, will increase the time of wetness underneath its surface and keep contaminants against the surface of the vehicle. The grit also adds some abrasive stresses to the coatings and other material systems they contact.

Physical Layout. The trough will be roughly 75 feet long with sloping entrance and exits on each end. The grit depth should be maintained at approximately 4 inches. Bumps will be added to the trough to induce body twisting and flexing. The grit used within the trough will contain Gleason ball clay (fire clay dust), ASHTO# 10 (crusher dust), beach sand and liquid calcium chloride. The solids will be mixed in equal parts by volume. Water should be added at a ratio of 6:1 by volume. Final consistency is liquid rather than mud like. Salinity will be adjusted to 1% by addition of a concentrated salt solution (9 parts NaCl to 1 part CaCl). The grit trough should appear consistent in composition prior to initiation of the exposure. This can be accomplished by an initial pre-pass drive of the vehicle through the trough to mix up the material. The test vehicle should pass through the trough at speeds of 15±1 mph. Observation of the consistency of the grit trough solution will be made weekly. The grit trough solid material will be replaced every 2 phases or as needed. Salinity of the grit trough will be monitored twice weekly or as needed (due to rain events, makeup, etc.). Adjustments will be made to keep salinity between 1% and 1.5%.

Salinity Monitoring. Measuring its conductivity monitors the salinity of the solution. This is compared to experimentally derived conductivity values of a laboratory prepared solution. Since this solution is a ratio of chemicals the conductivity is unaffected by the volume from which the measurement is taken. Based on laboratory measurements the conductivity of the grit-trough solution should be maintained at 14.5 mS/cm + 10% (14.5 – 16.0 mS/cm). Deviations from this range should be adjusted by adding chemicals, in their proper ratios, if less than 14.5 mS/cm or by adding water if greater than 16.0 mS/cm.

Salt Splash/Mist

Purpose. The purpose of this facility is to apply a salt spray solution to all surfaces of the top and sides of the vehicle as well as solution to the bottom of the vehicle as would be seen during normal driving conditions. As the name implies, it consists of two facilities – a shallow trough of salt water which splashes the vehicle underside and a booth in which the salt water is misted over the vehicle. The vehicle will pass through each facility as part of this test cycle.

The purpose of the salt splash trough is to expose the undercarriage of the vehicle to high concentration salt solutions that will be present on roadways, typically from road deicing salts. The application includes exposure to fine mists from elevated speed travel.

The salt mist booth applies the corrosive salt solution to all areas of the vehicle by creating a fine mist all around the vehicle.

Physical Layout – Salt Splash Trough. The salt splash trough is approximately 75 feet long. The salt splash solution is 5% NaCl solution, by weight, mixed with potable water. The vehicle will pass through the trough four times, each at a different entry speed – 40, 30, 20, and 10 miles per hour. The intent of the varying entry speeds is to ensure a variety of wetting scenarios that uniformly yet realistically wet the underside of the vehicle. As a result, the entry speeds may be modified as necessary to achieve uniform and realistic wetting of different vehicle systems. The solution level will be checked daily to ensure a consistent depth of nominally 0.5-inches. The salt solution concentration for the area will be checked weekly.

Physical Layout – Salt Mist Booth. The salt mist booth is an enclosed work bay. Spray nozzles are positioned across the sides and top of the facility to provide full salt spray application to all exterior surfaces on the top, sides, front, and back of the vehicle. Nozzle positioning may be optimized for each separate vehicle design that undergoes testing to ensure that all surfaces are properly wetted. The vehicle remains stationary in the salt spray booth. The entrance and exit doors to the facility are closed during spraying to ensure that any wind will not affect the spray pattern. The spray time will be approximately one to two minutes. The level and chemistry of salt solution will be monitored daily, along with solution temperature. The spray nozzles will be inspected weekly along with all of the equipment associated with the holding tank, mixing tank, and spray application system.

The salt solution contains contaminants representative of elements found in the various natural environments that the vehicle will operate within. The solution must be carefully prepared to avoid formation of precipitates. The sodium bi-carbonate must be dissolved separately in water and then added to the solution of the other materials. If all solids are added together dry, an insoluble precipitate can form. The solution has the following mixture:

- 0.9% Sodium Chloride ($NaCl$)
- 0.1% Calcium Chloride ($CaCl_2$)
- 0.075% Sodium Bi-Carbonate ($NaHCO_3$)

Salinity Monitoring. The salinity of these solutions will be monitored in the same manner as the grit trough solution. The only change is the desired conductivity range of the 5% solution. For the splash trough solution the desired conductivity, also found through laboratory measurements, is 73.3 mS/cm + 10% (73.3 – 80.6 mS/cm). However, since the spray booth solution is the same as the grit-trough solution its conductivity range should be the same (14.5 – 16.0 mS/cm). Adjustments to either solution can be made in the same manner as for the grit trough.

Secondary Roads (Gravel Road)

Purpose. The purpose of the secondary road is to impart coating damage caused by stone impingement on the underbody of the vehicle. The gravel road also provides a high frequency, low amplitude input on the underbody and other body components, which may act as abrasive forces. Secondary roads are also traversed in the process of accessing the Trails and Cross-Country Roads.

Physical Layout. An improved gravel road course will be used to provide secondary road mileage. The course is a loop of about 2.1 miles with left and right curves. The surface is compacted gravel maintained by grading. The course is traveled at varying speeds consistent with safe vehicle operation. Maximum traveling speed is expected to be 45 miles per hour.

Cross-Country Road (Rolling Hills)

Purpose. The purpose of this portion of the test is to subject the vehicle to twisting and turning motions associated with traveling on cross-country terrain. In order to access the cross-country road, the vehicle must traverse 1.7 miles of Secondary Roads (see above).

Physical Layout. Cross-country road will be simulated using a rolling hill course. The course was designed to provide short, closely spaced grades. As a vehicle alternates between inclines and declines on this course, the engine and power train are subjected to rapid variations in loading. The surface consists of crushed stone compacted with stone dust binder. The course is 0.4 mile in length and contains a paved turn-around section at either end. Each "lap" consists of two passes through the facility for a total of 0.8 miles. The section will be traveled at 10 to 15 miles per hour.

Trails (Belgian Block)

Purpose. The purpose of this portion of the test is to subject the vehicle to intermediate frequency and force inputs typical of trails. In order to access the cross-country road, the vehicle must traverse 2.0 miles of Secondary Roads (see above).

Physical Layout. The facility consists of 0.7 miles of a Belgian Block course. The facility is paved with unevenly laid granite blocks forming an undulating surface. It duplicates the rough cobblestone road found in many parts of the world. The course is useful as a standard rough road for accelerated tests of wheeled vehicles, and is generally included in cycles of courses for vibration studies. The motion imparted to a vehicle is a random combination of roll and pitch and high frequency vibrations imparted by the granite paving blocks. The section will be traveled at 20 to 25 miles per hour.

Primary Roads (High Speed Test Track)

Purpose. The purpose of the high-speed test track is to induce high frequency vibration forces on joints and strain underbody components. These forces may cause some abrasive action. Higher speeds may also drive contaminants into crevice areas.

Physical Layout. The track is an evenly paved surface capable of allowing continuous travel of the vehicle at 50 mph. The oval-shaped facility consists of two straight sections, each 0.25-mile long, joined at each end by 0.25-mile sections of regular curvature to form an oval totaling 1 mile in length. The driver will enter the high-speed test track area and accelerate the vehicle to a maximum speed of 50 mph. The speed will be maintained for the designated number of laps, with slowing allowed only as required for safety purposes.

When transportation to the High Speed Test Track is not possible (due to excessive vehicle contamination or inaccessible roads), the primary road miles may be driven on the paved portions of the Munson Area Test Track. The required number of miles (4.0 or 5.0) shall be driven at the maximum safe speed.

Frame Twister

Purpose. The purpose of the frame twister is to provide a dynamic flexural input to the vehicle at the beginning and end of the test. The frame twister will be executed after phase 2 and phase 22. The purpose of executing the frame twister after cycle 2 is to flex the joints and allow initiation of corrosion in broken joints and seams early in the test. The purpose of the frame twister at the end of 22 years is to fully stress all structural components to ensure integrity after the cumulative corrosion.

Physical Layout. The frame twister was designed to deflect the opposite wheels of the vehicle in alternately contrary directions. This is accomplished by dividing the road in half and creating two separate series of hills (waves) on either side. These waves are 14 feet from peak to valley and are 180° degrees out of phase (i.e., when one wheel is at a peak the wheel on the opposite side of the vehicle is in a valley). At each peak's maximum point the wheel is raised 2-feet above the average height. At each valley's minimum point the wheel is lowered 2-feet below the average height. The total length of the course is 443 feet. The frame twister shall be traversed once at a speed not to exceed 5 mph.

Non-Driving Test Events

Subsequent to each driving cycle, the vehicle will either be placed in a humidity chamber to accelerate corrosion or be placed in ambient storage to allow natural corrosion to take place. The humidity chamber will only be used as necessary to achieve the target corrosion rates provided in Table 1. Following are descriptions of the two storage conditions.

Humidity Chamber

Purpose. The purpose of the humidity chamber is to create high temperature and humidity conditions that will accelerate the natural corrosion process. In effect, the booth will accelerate the reaction of the contaminants applied by the different test events with any exposed material on the vehicle.

Physical Layout. The humidity chamber has a working area sufficient to hold the vehicle being tested. Appropriate equipment is required to measure and also control the temperature and humidity at the specified levels. Circulation fans will be present to provide a moderate flow of the high humidity air throughout the chamber. The temperature will be held at 120 F, +/- 5 degrees. The relative humidity will be maintained at 100% in a condensing state. The resulting water fog will provide a condensation rate of 1-2 ml/hour in collection devices having a horizontal collection area of 80 cm^2. During designated test cycles, the vehicle will be placed into the humidity chamber for an eight-hour period. The temperature and humidity will be maintained at the specified levels for the duration of exposure.

The test vehicle will be placed into humidity booths as necessary to achieve the target corrosion rates in Table 1. As a starting point, we believe that the following number of booths will be required. *Note that this is a starting point only, the actual number of humidity booths per phase will be adjusted based on actual coupon corrosion rates.*

Table A 3. Number of Booths Each Phase as Required for Each Month

Month of the Year	Target Number of Booths per Phase
January	6
February	6
March	6
April	5
May	5
June	4
July	4
August	3
September	3
October	5
November	6
December	6

Ambient Storage

During many portions of the test duration, the vehicles will not be participating in any test events. During these times, the vehicle will be stored at ambient conditions in a sheltered location. The facility should be kept relatively protected from the environment. The location could be used for PMCS activities, inspections, photographs, and other miscellaneous activities. There is no specific requirement for the timing or duration of ambient storage events except that ambient storage time exceeding four days shall be modified to minimize corrosion.

Ambient Storage in Excess of Four Days

If holidays, unscheduled shutdowns, or other unforeseen events require that the vehicle be stored in excess of four days the vehicle shall be washed to remove contaminants and stored in a low humidity, preferably cool environment. The purpose is to minimize corrosion by reducing the effect of those components that contribute to corrosion (i.e., removing contaminants, minimizing moisture, and reducing temperature).

Vehicle Washing

The vehicle shall be washed twice during each test phase. The washing will take place prior to driving cycles 1 and 9. Washing shall not take place prior to a humidity booth. Washing shall consist of high-pressure potable water wash. If necessary, local areas of heavily caked mud may be removed at any time.

End-of-Phase Equipment Exercise

At the end of each test phase (15 cycles) or as necessary to validate functionality, critical systems will be exercised. This is both to ensure that they continue to be operational and to incorporate into the durability test any effects of accumulated grit, debris, and corrosion. The following systems shall be exercised:

- Kneeling Capability
- Spare Tire
- CTIS

End-of-Phase Inspection

At the end of each test phase (15 cycles) an inspection will be carried out which documents the corrosion observed, test incident reports (TIR's) are generated, and vehicle condition is photodocumented.

After the 10th, 15th, and 22nd phases the inspection will include personnel from TACOM and other interested parties. After the 22nd phase, a complete teardown inspection will be conducted. This will include disassembly of significant vehicle components and systems, opening of lap seams and other crevice areas, and removal of sheet metal as required to fully determine the extent of vehicle corrosion.

Any failed components shall be removed and replaced as necessary to ensure that the vehicle is fully operational. The failed parts will be evaluated to determine the cause of failure.

Vehicle Loading

The test vehicle shall be loaded in accordance with the following schedule. Troop seats shall be removed when the vehicle is loaded.

Table A 4. Vehicle Loading

Load	Test Phases
None	1 and 2
100% of Rated Payload	3 through 6
None	7 through 10
75% of Rated Payload	11 through 14
None	15 through 18
100% of Rated Payload	19 through 22

Test Monitoring Coupons, Paint Panels and Intentional Scribes

A variety of coupons and panels shall be exposed on the vehicle. The coupons and panels allow for monitoring the test severity for quality control purposes. More importantly, they provide feedback-allowing adjustment of the test variables so that target corrosion is achieved throughout the test. Coupons placement will be determined during pre-test efforts. Monitoring coupons and panels include:

Weight loss coupons - Weight loss coupons are made from 1008 steel and measure 1-inch by 2-inch by 1/8-inch. A total of 24 coupons will be installed on each rack allowing for duplicate pairs to be removed at each evaluation (a total of 12 evaluations will be performed). Weight loss coupons will be removed at 1, 2, 4, 6, 8, ..., 20 and 22 phases. Any corrosion on these panels will be removed by glass bead blasting and the weight loss due to this corrosion will be recorded. During these evaluations the outer most coupons (coupons 1 and 24) on each rack will be removed and replaced with new coupons. Thus, for each evaluation, interval and cumulative corrosion rates will be measured. These weight loss measurements are done to monitor the severity of corrosion each vehicle is subjected to throughout its evaluation. Weight loss coupons will be located beneath the cab (attached directly to the skid-plate protecting the radiator) and beneath the frame rail on the passenger's side of the vehicle to mimic locations evaluated during ACT I. In addition coupons will also be placed directly behind the passenger's side front wheel which corresponds to coupon locations used by GM for their testing. Additional racks may also be placed at other locations of the vehicle, these may include the roof and tailgate areas.

Painted Galvanized Panels - Two types of coating systems applied over galvanized panels are being used. The first system has an e-coat that is topcoated with a single component green CARC topcoat. The second system is GM's standard coating system. These panels measure 2-inch by 4-inch and will have an intentional scribe down the center. Duplicate panels will be placed in close proximity to the weight loss coupons, along with other strategic locations over the vehicle surface, and will be inspected for scribe creepage after each phase (test year). The CARC topcoated panels are used to monitor the extent of possible corrosion due to damage to the original coating system applied over surfaces with corrosion enhancements. The GM coated panels are used for comparison to GM's database for similarly coated panels evaluated using their test facilities.

Cold-Rolled Steel Panels - Two types of coating systems applied over cold-rolled steel panels are being used. The first system has an e-coat that is topcoated with a single component green CARC topcoat. The second system is GM's standard coating system. These panels measure 2-inch by 4-inch and will have an intentional scribe down the center. Duplicate panels will be placed in close proximity to the weight loss coupons, along with other strategic locations over the vehicle surface, and will be inspected for scribe creepage after each phase (test year). The CARC topcoated panels are used to monitor the extent of possible corrosion due to damage to the original coating system applied over surfaces without corrosion enhancements. The GM coated panels are used for comparison to GM's database for similarly coated panels evaluated using their test facilities.

In addition to painted panels, the vehicle body will also have intentional scribes. These scribes are meant to test the coating system's adhesion properties along with its' resistance to underfilm cutback. Intentional scribes will consist of one horizontal and one vertical line, at each location, which will penetrate through the entire coating system to the substrate. These lines will measure two inches in length and will not intersect at any point. Scribes will be made using a straight edge and several passes with a razor knife to penetrate the coating system to the substrate. Locations for scribes have been identified for the cab, cargo bed and frame rails of each vehicle. Five locations have been identified for the cab, which include: the cab front, cab side, cab roof, cab back and cab door. Four possible locations have been identified for the cargo bed, which include: two scribes on the tailgate and two scribes on the underside of the bed. Two locations of the frame rails will also be scribed.

Evaluation Techniques

During corrosion testing the test vehicle, painted panels and weight loss coupons will be evaluated for signs of corrosion. Several techniques, some unique to items being evaluated, will be used for evaluation. These are discussed below.

Scribe Cutback/Creepage

Under paint film cutback at the intentional scribe will be evaluated using GM's standard inspection technique. During this inspection the maximum cutback (shown by bubbled paint) is measured from the center of to either side of the intentional scribe. The total creepage is the sum of these two measurements. For scribes with filiform corrosion (threadlike structure that is directional in growth) scribe creepage is measured as above, but includes a filiform supplement. This supplement is the addition of the maximum filiform corrosion measured on either side of the scribe. Appendix B shows how to perform these measurements.

Stages of Corrosion

The stage of corrosion in a given area is evaluated based on a numeric rating scale. This rating scale is based on GM's rating system giving a numerical value based on the percent of total area rusted. This rating is a visual estimate of this area based on developed standards. Appendix B lists this rating scale and contains visual standards used for this rating.

Weight Loss

Weight loss due to corrosion is measured only on weight loss coupons. These coupons are exposed on the test vehicle for a specific number of test years. Following this each is removed and all corrosion product is removed by glass bead blasting. Initial and final weight measurements (before exposure and after corrosion removal) are made to determine loss due to corrosion. This weight loss can be made into penetration through calculation. Appendix B lists this procedure and contains the necessary calculation to convert weight loss to penetration.

Vehicle Maintenance

Vehicle maintenance during the test should mirror the type of maintenance that is expected from the customer over the duration of the test. The degree of acceleration that the FMTV ACT has on different components and materials has to be factored into the maintenance schedule. For example, components and materials whose aging does not accelerate with the corrosive input, such as grease and oil, should not be accelerated (i.e., not conducted in accordance with the regular maintenance schedule based on the acceleration rate of the test - one test "year" would not necessarily equal a "year" for required maintenance). The maintenance of these materials and other general maintenance will be performed at specified intervals designated by total driving mileage. However, other maintenance issues that are affected by the corrosive impact, such as cleaning, should be accelerated somewhat. The attached table outlines the PCMS schedule for the test. The charts have been developed from the FMTV Preventative Maintenance Checks and Services(PMCS) sections of the Tech manuals (TM). There has been some rearrangement to accommodate the test schedule. The following is a break down of those intervals and outlining accompanying documentation from the PMCS section of the TM's. For the purpose of this test, these PMCS intervals may be changed or altered by the test community to accommodate test scheduling and corrosion evaluation.

Approx. 1 cycle = 82 miles
Approx. 1 Phase = 1,230 miles

Table A 5. PMCS Requirements

Phase	***Miles***	***Cycles/Maint interval***
1	1,230	15 end of phase check (eop)
2	2,460	30 eop, (minor quarterly)
3	3,690	45 eop, quarterly
4	4,920	60 eop
5	6,150	75 eop, semi, quarterly
6	7,380	90 eop
7	8,610	105 eop, quarterly
8	9,840	120 eop
9	11,070	135 eop, (minor quarterly)
10	12,300	150 eop, annual, semi, quarterly, 10 yr milestone
11	13,530	165 eop
12	14,760	180 eop, quarterly
13	15,990	195 eop
14	17,220	210 eop, (minor quarterly
15	18,450	225 eop, quarterly, 15 yr milestone
16	19,680	240 eop
17	20,910	255 eop, quarterly
18	22,140	270 eop
19	23,370	285 eop, bi-annual, annual, semi, quarterly
20	24,600	300 eop
21	25,830	315 eop
22	27,060	330 END OF TEST COMPLETE TEARDOWN
NAME	WHEN	DESCRIPTION
Vehicle Exterior	Before Cycle	Walk around to look for obvious damage, ie; fluid leaks, damage to drive train, lights, reflectors, tires, mirrors. make a brief but thorough observation of entire vehicle.
Windshield, Windows, Mirrors Windshield Wipers, and Washer Reservoir	Before Cycle	Check for windshield or window cracks, wiper and switch damage, low fluid(replenish if needed) and any sight obstruction to driver. Driver should check mirror sight alignment.

Coolant	Before Cycle	Check coolant level
Fuel Tank	Before Cycle	Check for fuel in tank
Spare Tire Strap	Before Cycle	Check that strap is tight, not damaged, and that hydraulic knobs are in correct position.
Cab Latch	Before Cycle	Check cab latch indicator button is in latched position
Air / Hydraulic Power Unit	Before Cycle	Check dipstick oil level
Seat Belts	Before Cycle	Check 3 seat belts for proper operation
Driver's Seat	Before Cycle	Check forward/ backward adjust control
Fire Extinguisher	Before Cycle	Check if missing or damaged and pressure is approx. 150 psi
Lighted Indicator Display	Before Cycle	Turn master power on and check that indicator lights are on for: stop, park brake, emergency brake, rear brake air, front brake air, and engine oil pressure
**Starter	Before Cycle	Check to see if starter engages smoothly and turns engine at normal cranking speed.
**Engine	Before Cycle	Listen for unusual engine noises or vibration being aware of smells of oil, fuel and exhaust that is out of ordinary.
Oil Pressure Gauge	Before Cycle	Start Engine and check oil pressure gauge is between 15 - 80 psi
Tachometer	Before Cycle	Check that range while idling engine is at 750-850 rpm
Water Temp. Gauge	Before Cycle	Check that gauge reads 160 - 230 F
Air Filter Restriction Gauge	Before Cycle	Check and reset if > 25 (red), if still red zone then air cleaner must be serviced then rechecked
Front Brake Air and Rear Brake Air Gauges	Before Cycle	Check that gauges read 60 - 120 psi
Volts Gauge	Before Cycle	Check that gauge reads 26 - 30 volts
Fuel Gauge	Before Cycle	Compare gauge with observed fuel level
System Park Control	Before Cycle	Pull out control, set ECU shift selector to any forward gear while at idle rpm
Transmission ECU Push Button Shift Selector	Before Cycle	Check that it operates in all gears

Turn Signal Control	Before Cycle	Check control and indicators for proper direction
Hazard Lights Switch	Before Cycle	Check switch for proper operation
Controls and Indicators	During Cycle	Monitor all gauges, lights, headlights, turnsignals, buzzers and horn during operation
Engine Operation	During Cycle	Monitor for excessive engine exhaust, unusual noises, rough running, misfiring or other unusual engine operation during idle, operating speeds or acceleration. Be alert for excessive odors of oil, fuel and exhaust.
**Transmission	During cycle	Monitor transmission responses to shifting and for smoothness of operation in all speed ranges. Be alert for unusual noises and difficulty in shifting in any speed range.
**Accelerator Pedal	During Cycle	Monitor pedal for any sticking.
CTIS	During Cycle	Monitor CTIS operation and ECU operation.
Air Dryer	During Cycle	Listen for dryer discharge when pressure approx. 120
Steering	During Cycle	Monitor for noises, binding, or turn difficulty
Service Brakes	During Cycle	Monitor if they stop vehicle, pull it to one side when applied, or make excessive noise
**Vehicle Cargo Bed	During Cycle	Monitor payload and anti-brake load sensor during vehicle operation. Monitor load tiedowns.
**Spare Tire Tiedown	During Cycle	Monitor spare tire tiedown and safety chain
**Vehicle Operation	During Cycle	Monitor other vehicle operations as windows, doors windshield wipers, horn, signals etc. Monitor interior of cab for noticeable leaks as around windshield, windows, floor, doors or roof hatch.
Hydraulic Manifold	After Cycle	Inspect hydraulic manifold for leakage
Cab Tilt Hydraulic Cylinder	After Cycle	Raise cab, check cylinder and linkage for oil leaks or damage
Cab Latch	After Cycle	Check latch for damage and hoses for oil leaks

Fuel / Water Separator	After Cycle	Check it for leaks / damage, for presence of water in bowl of separator; if present, turn knurled nut to left to open, drain until pure fuel remains, and close
Engine Compartment	After Cycle	Inspect for damage that would impair operation
Engine Oil	After Cycle	Check oil level (should be between ADD and FULL)
Hydraulic Reservoir (if equipped)	After Cycle	Check oil level.
Transmission Oil	After Cycle	Check transmission oil level (should be between HOT ADD and HOT FULL)
Air Tanks	After Cycle	With engine off, listen for tank air leaks, open air tank drain valves and drain moisture
Tires	After Cycle	Check tire for damage or low air and remove sharp objects
Horn Button	After Cycle	Check it for proper operation
Lights	After Cycle	Check for operation and damage of all lights and reflectors
Light Switches	After Cycle	Place all in off position
**Door, Window and Mirrors	After Cycle	Check Condition and operation
**Spare Tire	After Cycle	Check for damage and appropriate pressure
**Power steering Reservoir (weekly)	After Cycle	Check for appropriate level.
**Driveshaft	After Cycle	Check driveshaft and related hardware.
**Cargo bed Tiedown rings and Payload	After Cycle	Check tiedown rings for any sight of damage or deformation and check that payload is secured properly.
AT END OF EACH PHASE VEHICLE CORROSION EVALUATION WILL TAKE PLACE.		DURING NORMAL MAINTENANCE CHECKS AND ALSO POSSIBLY USING SEMI-ANNUAL ITEMS 1 THRU 49 AND WHATEVER ITINERARY TEST SITE MAY CHOOSE TO SCHEDULE TO EVALUATE VEHICLE FOR CORROSION.
Mounting/Coupling Hardware and Hoses/Tubes (weekly)	End of Phase (15 Cycles)	Check parts for looseness or damage, tighten, or notify Maintenance if damaged to point of leakage (refer to TM 9-2320-365-10 under weekly in table 2-1, pg 2-55 for complete break down)
Heater/Defrost Controls(weekly)	End of Phase (15 Cycles)	Check controls for proper operation

Wheels and Tires(weekly)	End of Phase (15 Cycles)	Check (1)tire tread depth, (2)wheel assembly for damage, (3)wheel studs and nuts for looseness, and (4) tire pressures with gauge for each CTIS setting
Hydraulic Reservoir (if equipped) (weekly)	End of Phase (15 Cycles)	Check reservoir, lines and connections for leaks; check for clogged, damaged, or missing hydraulic reservoir strainer
Batteries (weekly)	End of Phase (15 Cycles)	Open cover and (1)check for damaged casings, terminals, and security of mounting by noticing cable clamps are secure, (2)test battery fluid level, (3)check battery box for corrosion and close cover
Air Dryer (weekly)	End of Cycle (15 Cycles)	Check component for loose or damaged mountings and check heater cord.
Underneath Vehicle (weekly)	End of Phase (15 Cycles)	Check underneath vehicle for obvious damage to leaf springs, engine, transmission, frame, cross members, air hoses, fittings, leakage, shock absorbers for leaks, shock absorber hardware, drive shaft and related hardware.
Electrical Connectors (weekly)	End of Phase (15 Cycles)	Check connectors for damage
Gladhands (weekly)	End of Phase (15 Cycles)	Check gladhands for damage and air leaks and lubricate coupler seals
Printle Hook (weekly)	End of Phase (15 Cycles)	Check it for looseness or damage to locking mechanism
Shackles (weekly)	End of Phase (15 Cycles)	Check leaf spring shackles and mounting pin for damage
Fuel Tank (weekly)	End of Phase (15 Cycles)	Check it (1)for clogs, damage, or missing fuel strainer, (2)that fuel cap is not loose or damaged, (3)fuel tank, hoses, and connections for leaks
Drive Belts, Fan, and Pulleys (weekly)	End of Phase (15 Cycles)	Raise cab, (1)check drive belts for damage, (2)and check belts for tightness (should have 0.5 in play)

Fan Clutch (weekly)	End of Phase (15 Cycles)	Check it for missing or loose mounting hardware
Radiator Hoses (weekly)	End of Phase (15 Cycles)	Check for cracks or excessive wear or loose hose clamps; check radiator for leaks or damage
Fuel Filter (weekly)	End of Phase (15 Cycles)	Check it for leaks or damage
Power Steering Reservoir (weekly)	End of Phase (15 cycles)	Check power steering reservoir for leaks or obvious damage. Check for proper fluid level is between maximum and minimum level.
Charge Air (weekly)	End of Phase (15 Cycles)	(1)Check for loose or missing air hose clamps at intake cleaner, engine air inlet and cooler assemblies, and engine air aspiration system; (2)Check hoses at intake air cleaner to turbocharger inlet, that to charge air cooler inlet, that to engine air inlet
Springs (monthly)	End of Phase (15 Cycles)	At 1,000 miles, check U-Bolts for proper tightness, 390-510 ft lbs.
Ether Starting Aid (Monthly)	End of Phase (15 Cycles)	Check ether cylinder for damaged or loose mounts and check cylinder and injection valve for damage
Rifle Stowage Mount (Monthly)	End of Phase (15 Cycles)	Check that upper and lower mount bolts aren't broke or missing and that mount latches aren't too loose or binding
Warning Light (if equipped) (Monthly)	End of Phase (15 Cycles)	Check light for proper operation
Hydraulic Manifold (Monthly)	End of Phase (15 Cycles)	Inspect for leakage
Hydraulic Hand Pump (Monthly)	End of Phase (15 Cycles)	Remove tool kit handle and install in hand pump and pump 5 - 8 cycles

Tool Kit (monthly)	End of Phase (15 Cycles)	Check for water on bottom of box. Clean out, if necessary.
Front Lifting Beams and Spreader Bars (Monthly Lube)	End of Phase (15 cycles)	Check beams for damage, lube only on a as needed basis
Air hydraulic Unit (Monthly Fluid Check)	End of Phase (15 cycles)	Check fluid level at gage at the end of each phase.
Cargo Bed and tie down rings(oil can points every 1,000 miles)	End of Phase (15 cycles)	Check (1)cargo bed mounting screws on both sides, (2)inside panel stowage compartments under bed for damage, (3)lift beam and its lock pin on both sides, (4)spreader bar on both sides for damage, and (5)tiedown rings for damage. Lube cargo bed tie down rings on as needed basis. Lube all cargo bed storage door hinges only on as needed basis(not in manual) .
Cargo Bed Sides and Tailgate (Oil can points every 1,000 miles)	End of Phase (15 cycles)	Check (1)that sides and tailgate are not damaged, (2)its hinges are not damaged, and (3)latches are not missing or damaged. Lubricate drop side and tailgate hinges only on as needed basis.
Cab Door Latches and Hinges (Oil can points every 1,000 miles)	End of Phase (15 cycles)	Lubricate cab doors on as needed basis. Lubricate door strike plate a locking latch on as needed basis. (Possible application of door interior lubrication)
Battery Box Cover Latches (Oil can points every 1,000 miles)	End of Phase (15 Cycles)	Lubricate latches only on as needed basis.
Spare Tire and Retainer Davit Collar (Oil can points every 1,000 miles)	End of Phase (15 Cycles)	Check spare for damage, air pressure, wear beyond wear bar and that tire is properly secured(monthly) Lubricate collar only on as needed basis.(semi or 1,000)
Ladder	End of Phase (15 cycles)	Remove and check ladder for cracked or broken welds
Troopseats (if equipped)	End of Phase (15 cycles)	Check legs, hinge pins, seat and backrest functions, belts and check that the belt secures the seat
3,000 MILE / QUARTERLY		Refer TM 9-2320-365-20-2, pg H-2 to H-21

CAUTION, refer to note, test may be severe condition requiring lubrication every 1,000 miles or end of each phase		Lubricate front & rear axle spring bolt & shackle Note 18, view H,AE,& I
CAUTION, refer to note, test may be severe condition requiring lubrication every 1,000 miles or end of each phase		Lubricate universal & slip joints Note 9 , view P
		Check oil level front & rear axle Note 11, view T
CAUTION, refer to note, test may be severe condition requiring lubrication every 1,000 miles or end of each phase.		Lubricate axle shaft U-joints Note 20, view U
		Check fluid wheelend planetary hubs Note 12, view V
6,000 mile, SEMI-ANNUAL		Refer TM 9-2320-365-20-1,pg H-2 to H-21, 2-9 TO 2-52
		Remove and clean engine crankcase breather Note 17, view A
		Replace particle fuel filter Note 6, view A
		Replace filter fuel/water separator Note 5, view B
		Lubricate towing pintle Note 16, view J
6K EXCEPTION, change oil at end of phase 4 for 5,000 mile initial change		Drain and fill engine crankcase Note 1, view C
6K EXCEPTION, replace oil filter with initial oil change at end of phase 4 for 5,000 mile oil change		Change oil filter Note 2 view C
		Lubricate tie rod ends Note 13, view N

		Service batteries in accordance to TM 9-6140-200-14 Note 19, view Q
CAUTION, refer to note, test may be severe condition requiring lubrication every 1,000 miles or at end of each phase.		Lubricate steering knuckles Note 20, view U
CAUTION, refer to note, test may be severe condition requiring cleaning and lubrication every 3,000 miles or every quarterly.		Clean and lubricate brake wedge and air chamber, brake spider, self adjuster Note 21, view L & M
CAUTION, refer to note, test may be severe condition requiring cleaning and lubrication every 1,000 miles or end of each phase.		Front lifting beams Note 24, view AD
ITEM 1		Road test may not be required for below checks.
ITEM 2		Wheels and hubs, check manifold filter, other checks may be part of other PMCS intervals.
ITEM 3		Service brakes accordingly. Other checks may be part of other PMCS intervals.
ITEM 4		Shock absorbers, check rubber bushings, para 15-3, 15-4, other checks may be part of other PMCS intervals.
ITEM 5		Axles may be part of other PMCS intervals.
ITEM 6		Axle breather valve, remove and clean and reinstall, refer to note, other checks may be part of other PMCS intervals
ITEM 7		Propeller shafts, check torque on strap bolts. Other checks may be part of other PMCS intervals.
ITEM 8		Transmission, perform diagnostic check as in item 45, other checks may be part of other PMCS intervals.
ITEM 9		Engine mounts, may be part of other PMCS intervals.
ITEM 10		Engine crank case, may be part of other PMCS intervals.
ITEM 11		Engine wiring, may be part of other PMCS intervals.

ITEM 12		Air System, Air dryer, may be part of other PMCS intervals.
ITEM 13		Exhaust system, may be part of other PMCS intervals.
ITEM 14		Stabilizer Bar, may be part of other PMCS intervals.
ITEM 15		Pintle hook, may be part of other PMCS intervals.
ITEM 16		Vehicle exterior, may be part of other PMCS intervals.
ITEM 17		Air cleaner, check torque of clamps, other checks are part of other PMCS intervals.
ITEM 18		Check battery cells and record specific gravity of each cell. Other checks are part of other PMCS intervals.
ITEM 19		Spare tire retainer, may be part of other PMCS intervals.
ITEM 20		Cab lift hydraulic cylinder, may be part of other PMCS intervals.
ITEM 21		Cab Hydraulic latch, may be part of other PMCS intervals.
ITEM 22		Air –Hydraulic unit, may be part of other PMCS intervals.
ITEM 23		Cab suspension cylinder, may part of other PMCS intervals.
ITEM 24		Perform complete steering mechanical function inspection including front wheel alignment as in ITEM 44. Other checks may be part of other PMCS intervals.
ITEM 25		Pulley Damper AS PER TEST SITE DISCREETION.
ITEM 26, 27, 28		Remove belts and check belts, pulleys and brackets, other checks may be part of other PMCS intervals.
ITEM 29		Throttle position sensor, may be part of other PMCS intervals.
ITEM 30		Engine, may be part of other PMCS intervals.
ITEM 31		Turbo-charger, may be part of other PMCS checks.
ITEM 32		Charge air cooler tubes, check for torque on hose clamps, other checks may be part of other PMCS intervals.
ITEM 33		Charge air cooler, may be part of other PMCS intervals.

ITEM 34		Exhaust and intake manifold, may be part of other PMCS intervals.
ITEM 35		Engine crankcase breather, may be part of other PMCS intervals.
ITEM 36		Engine wiring, may be part of other PMCS intervals.
ITEM 37		Air compressor and air compressor governor, may be part of other PMCS intervals.
ITEM 38		Cooling system, test coolant for possible replacement, other checks may be part of other PMCS intervals.
ITEM 39		Thermostat housing, check for tightness, other checks may be part of other PMCS intervals.
ITEM 40		Water pump, check for tightness, other checks may be part of other PMCS intervals
ITEM 41		Fan blade and clutch, check for loose bolts, other checks may be part of other PMCS intervals.
ITEM 42		Radiator, may be part of other PMCS intervals.
ITEM 43		Fuel water separator, other checks may be part of other PMCS intervals.
ITEM 44		Wheel alignment, refer to item 24.
ITEM 45		Transmission, refer to item 8.
ITEM 46		Hydraulic reservoir, may be part of other PMCS intervals.
ITEM 47		N/A, winch cable
ITEM 48		N/A, winch
ITEM 49		Cargo bed, may be part of other PMCS intervals.
12,000 Mile, Annual		Refer TM 9-2320-365-20-2,pg H-2 to H-21
		Repack front and rear axle inner wheel bearing Note 22
		Service air dryer Note 25, View AF
24,000 Mile, Bi-Annual		Refer TM 9-2320-365-20-2,pg H-2 to H-21
		Service cooling system Note 7

		Service transmission Note 3, View D, E and F
		Service power steering reservoir Note 4, View G
		Service hydraulic reservoir Note 8, View X
		Service front and rear axle Note 11, View T
		Service back up hydraulic pump Note 10, View R
		Service Air/Hydraulic power unit Note 10, View S

Appendix 1: Preliminary Testing

Humidity Chamber Testing

Humidity chamber exposure is an important input in this accelerated corrosion test (ACT). By exposing the vehicle to a high temperature, high humidity environment natural corrosion is accelerated. This is crucial to get the equivalent of 22 years field exposure in a year and a half test period. The humidity chamber that will be used at Aberdeen Proving Ground (APG) was characterized on two separate occasions.

The humidity chamber was evaluated in the same manner as the corrosivity of the corrosion test will be monitored. Weight loss coupons were positioned throughout the humidity chamber to determine the corrosiveness at various locations. In addition, a graduated cylinder with a 4-inch funnel was placed next to each location to monitor the collection rates at those locations.

During the first evaluation one set of coupons was placed in five locations throughout the chamber. These were exposed for a period of 8 hours to a 120 ± 2° F and 100 ± 1% RH humidity chamber followed by 16 hours exposure to ambient conditions. Following each 24-hour period the two outermost coupons were removed along with an additional set of coupons for weight loss measurements. The outermost coupons were replaced with fresh samples and the exposure cycle was restarted. This cycle was repeated six times. The weight loss data generated by these measurements gave both interval and cumulative weight loss due to corrosion. This was compared with standard weight loss values developed by General Motors (GM). The weight loss observed at APG was less than the standard values developed by GM and collection rates were less than the specified 1-2 mL/hr.

During the second evaluation two duplicate sets of coupons were placed in five locations throughout the chamber. The primary set (set A) followed the same exposure procedure as above. The secondary set (Set B) were also exposed for a period of 8 hours to a 120 ± 2° F and 100 ± 1% RH humidity chamber. However, following this the coupons were exposed to 140 ± 2° F and <50 ± 1% RH environment for 5 hours (excluding a ramp-up time of 3 hours) to facilitate drying and further accelerate corrosion rates. Coupons were then exposed to 8 hours of ambient conditions. The removal/replacement procedure listed above was followed for both sets. This cycle was repeated four times. The weight loss data generated by this test was also compared to GM's standards. Weight loss, due to corrosion, for set A was still lower than GM standard values. However, the addition of the dry off cycle along with other chamber modifications resulted in weight loss and collection rates closer to GM's standards.

Memos dated 3/20/98 and 4/14/98 present and discuss the data obtained during these evaluations in further detail.

Six Day Corrosion Test

Following completion of modifications to the Munson Test Track at APG a 6-day test was performed using a representative vehicle. This test was performed to evaluate two important portions of the corrosion test. The first portion characterized the splash patters on the undercarriage resulting from driving through the grit and splash troughs along with the wetting of the vehicle exterior from the solution spray booth. This evaluation was performed prior to and periodically during the driving events of the ACT.

The second potion evaluated the general corrosion resulting from exposure to high humidity conditions following each driving cycle. This was done to determine if the calculated number of “booths” (8-hour exposure in the humidity chamber) is sufficient to provide the required levels of corrosion. These corrosion levels were monitored using weight loss coupons. The same exposure and weighing procedure was followed as done for the Humidity Chamber test. The three locations coupons were mounted are: beneath the cab on the skid plate (same location as in ACT I), beneath the frame rail on the passenger’s side (same location as in ACT I) and beneath the horizontal portion of the splash guard directly behind the passenger’s side front tire (same location as used by GM). The corrosivity of the test was monitored at each location and correlated to expected penetration.

Scribe Cutback/Creepage

A scribe is an intentional defect made through a coating system to the substrate is it applied over. These defects are typically linear in nature and are made by repeatedly passing a razor knife over a coating, using a straight edge as a guide, until the substrate is reached. This test is used to determine the systems ability to inhibit underfilm corrosion.

Underfilm corrosion is identified as bubbling of the paint directly adjacent to this defect. The maximum distance this occurs at on either side of the intentional scribe is measured. The total cutback is the sum of these values. When filiform corrosion (threadlike structures following a specific direction) is present special consideration must be given. The measured cutback now has two components. The first is the same as above, the second follows the same technique, but measures the maximum distance of filiform corrosion propagation. Figures B.1 and B.2 show sample scribes and measurements to be made on each.

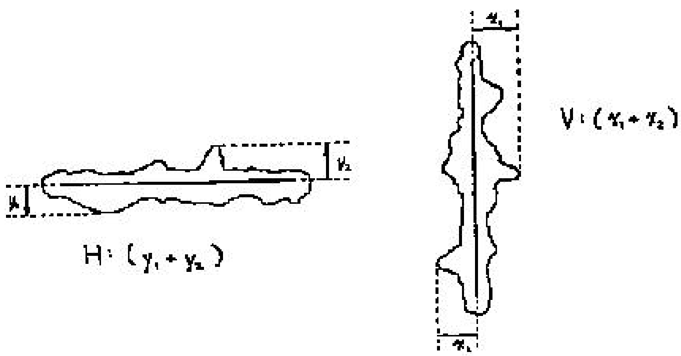

Figure A 1. Scribe Cutback Measurement Technique.

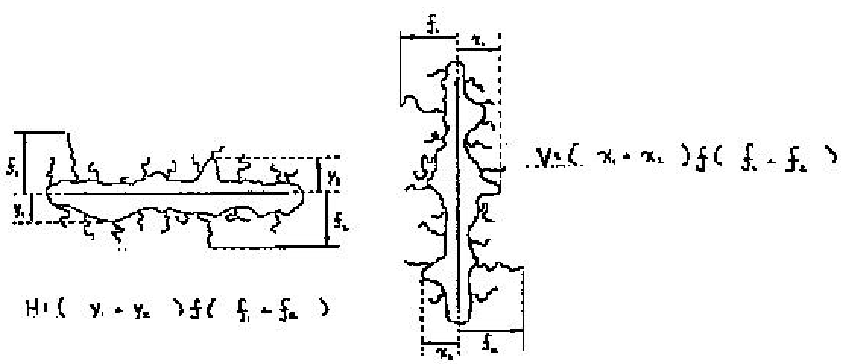

Figure A 2. Scribe Cutback Measurement Technique With Filiform Corrosion Propagation.

Stages of Corrosion

In order to better document the condition of the vehicle over time the following rating system has been developed. This system is visual in nature and provides a numerical value corresponding to the percent of the total area showing corrosion (rusting). This rating system is based on the previous system used by the Army, but incorporates a broader range of conditions like GM's standard. Table B.1 below shows the proposed rating scale and relates it to the original Army's and GM's rating systems. Figure B.3 shows the visual standards used to determine the rating.

Table A 6. Rating Scale

Old Army	GM Rating	New Army	Description
0	10	0	No visible corrosion (red rust)
1	9	0.05	One or Two small red rust spots
	8	0.1	Some small red rust spots
	7	0.2	10% red rust
	6	0.5	25% red rust
	5	1	50% red rust
1	4	1.5	75 % red rust
2	3	2	100% red rust
3	2	3	Obvious metal loss
3-4	1	4	Perforation of metal substrate

Weight Loss

Weight loss measurements are only used for corrosion rate coupons. These are 1008 steel coupons used to measure the severity of exposure throughout the test. Coupons measure 2 by 1 by 1/8-inch. Each is cleaned with acetone and weighed prior to exposure. Following exposure coupons are removed and glass bead blasted to remove any corrosion product. Following this they are again cleaned with acetone and re-weighed. The amount of weight loss is used to calculate the penetration, in µm, which is compared to estimated penetration values. The equation for this calculation is listed below:

$$penetration = \frac{weightloss}{density \times surfacearea} = \frac{weightloss}{\left(7.86 g/cm^3 \times 30.3 cm^2\right) \div 10{,}000 mm/cm} = \frac{weightloss}{2.38 \times 10^{-2} g/mm}$$